Characterization of Photonic Cristal Cavities: Investigation on the Coupling between Microresonators and Waveguides

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Photonic crystals (PC) are recognised as candidates to provide an effective control of light at micrometer size. In particular, for applications in the fields of optical telecommunications and interconnects, they can be used to elaborate photonic integrated circuits comprising sources, detectors, modulators, wavelength filters, and waveguides. As they can be fabricated on semiconductor layers using mature microelectronic and optoelectronic technologies, two-dimensional PC (2D PC) have recently been the subject of widespread theoretical and experimental investigation. In this case the vertical confinement is ensured by index contrast with substrate and cladding layers. PC-based integrated photonics will be at hand if we can control the properties of microresonators and waveguides and then the coupling between this two building blocks.

In this work, we report on properties of PC-based microcavities fabricated on InP suspended membranes. Their characterization is based on the observation of diffracted photoluminescence (PL) [1]. In order to generate a PL signal, a light beam is focused inside the microcavity. Mode spectra are then extracted from the light that is diffracted by holes in free space. Comparison is made with theoretical calculations obtained by a 3D plane wave method.

We investigate the influence of several parameters (cavity shape, PC filling factor…) on the spectral properties of PC cavities (figure 1). Modes frequencies and quality factor are particularly addressed. Then, modal properties of PC waveguides are measured. In our experiments, the waveguides are closed at both ends (by PC holes) in order to induce Fabry-Perot oscillations of guided modes in the resultant linear cavity (figure 2). The spectral response of the latter leads to the determination of group velocity and propagation losses of waveguided modes. Finally, coupling experiments are performed between a rectangular PC cavity and a PC waveguide. Light is generated inside the cavity and the resulting PL spectrum is measured (figure 3). When a waveguide is positioned near the cavity, some modes, previously diffracted, are no more observed, indicating a coupling of the light in the waveguide.

[1] : P. Pottier, C. Seassal, X. Letartre, J.-L. Leclercq, P. Viktorovitch, D. Cassagne, and C. Jouanin, J. Lightwave Technol. **17**, 2058 (1999).

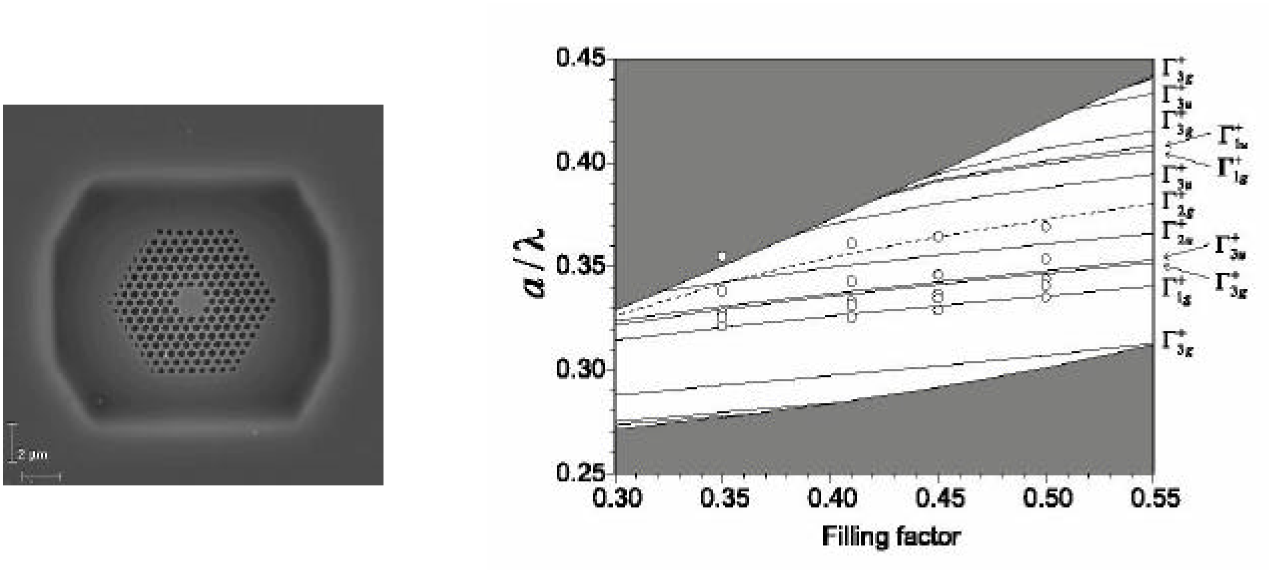

Figure 1: Evolution of cavity mode frequencies inside the TE gap as a function of the air-filling factor, for the H2 cavity shown on the SEM micrograph

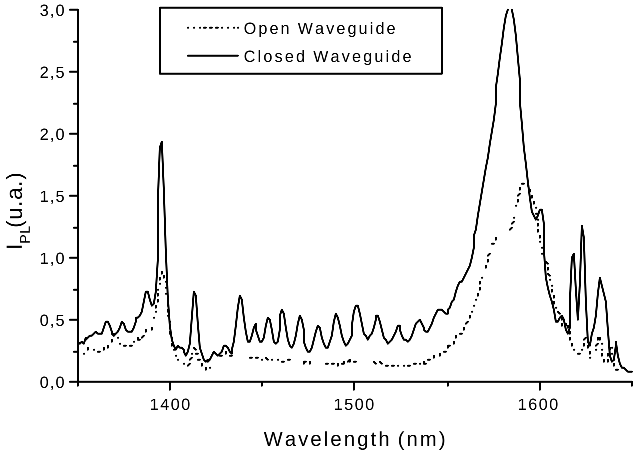

Figure 2 : Photoluminescence spectra of open and closed PC waveguides

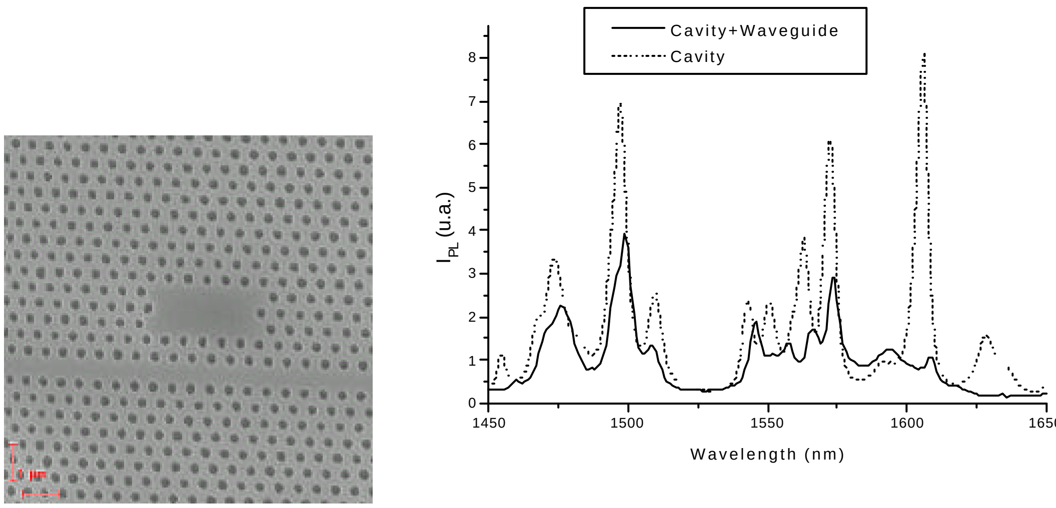

Figure 3: Photoluminescence spectra of a rectangular PC cavity: alone (straight line), with a PC waveguide as shown on the SEM micrograph (doted line)